Liquid Nitrogen Bulk Storage Maintenance

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Agenda

- Purpose
- Background
- Scope
- Work Completed
- Findings/Lessons Learned
- Path Forward
- Recommendations
- Questions

Purpose

- **During fiscal year 2016, we started a major maintenance project on our 6 bulk storage Liquid Nitrogen tanks at JSC.**
  - **Primary Goal: Improve efficiency of tank vacuum annulus (eliminate leaks).**
  - **Secondary Goal: Check condition of perlite insulation and system components.**

Background

- Over the period of 6 months after cleaning tank exterior, multiple tanks saw steady increase in pressure on vacuum annulus.

- During test in Chamber A, one of the LN2 bulk storage tanks lost vacuum on the annulus.
  - Vacuum pressure steadily rose over 2 days
  - Vacuum pump eventually overcome and failed
  - LN2 had to be transferred out of tank

Project Scope

- Replace vacuum pipe spools from vacuum pumps to main tanks

Project Scope

- Replace positive pressure relief devices on 2 tanks (vacuum side).

Project Scope

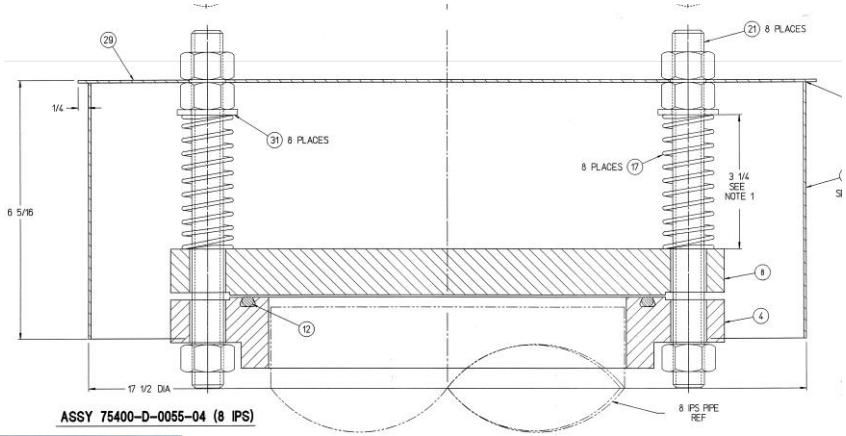
- Replace other leaking and leak-prone components.

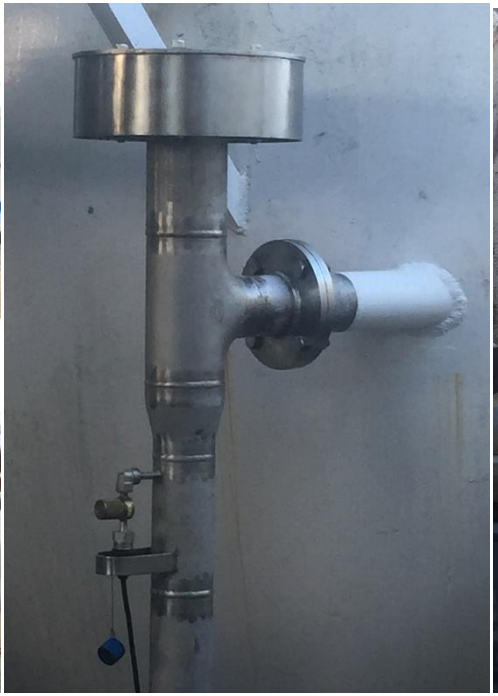
Work Completed

- Vacuum pipe spools replaced (all 6 tanks).
  - Mechanical joints/connections minimized
  - Unnecessary components eliminated

Work Completed

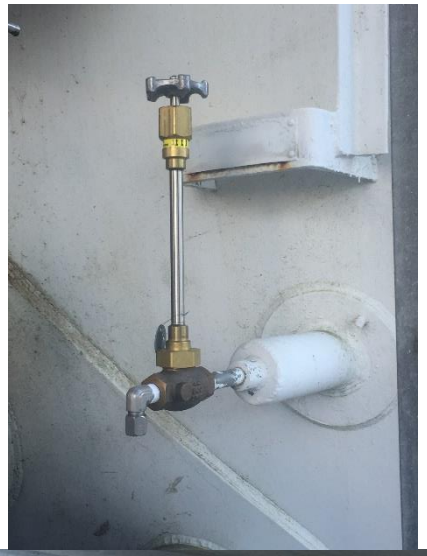
- Relief devices replaced (2 tanks).

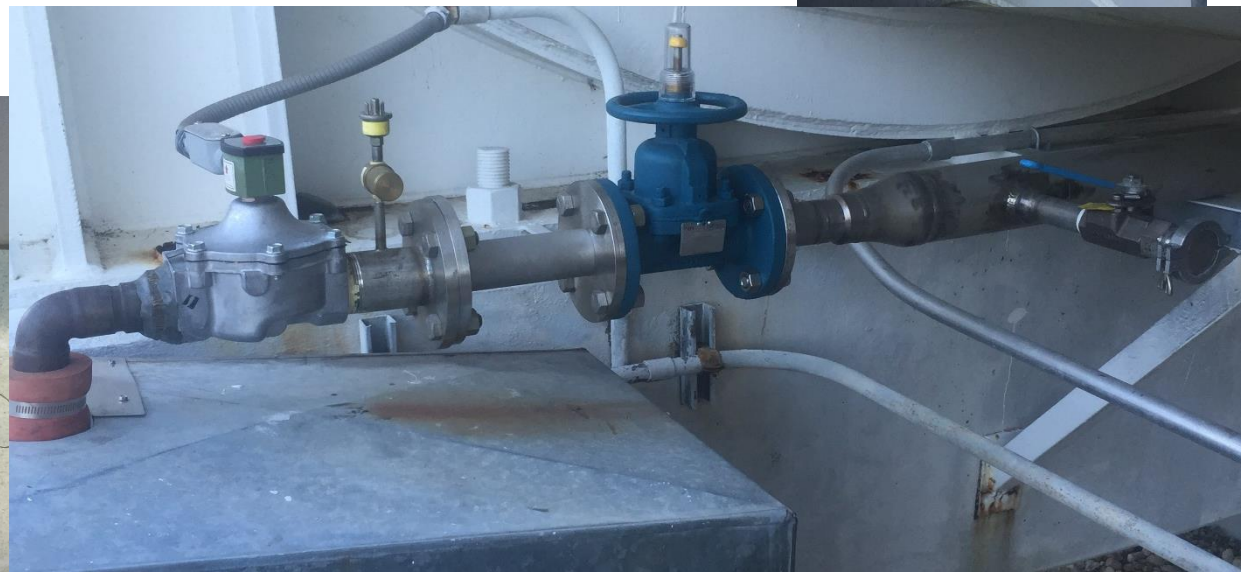




Work Completed

- Replaced non-vacuum valves on various ports
- Added new vacuum sensor ports
- Capped/sealed extraneous ports
- Replaced manual vacuum isolation valves
- Replaced solenoid vacuum isolation valves





Findings/Lessons Learned

- Years of leaks (masked by continuous pumping) resulted in large accumulation of water in annulus
  - Inner vessel acted as a cryo-pump for water until becoming saturated
  - Removing water to bring tanks back online has been a challenge
    - Heating inner vessel to 100+°C
    - LN2 cold trap on vacuum line
- Additional leaks found on pressure
- relief devices for remaining 4 tanks
  - Utilize burst disks in conjunction with
  - check valves in event of valve failure
  - Also determined relief devices under-
  - sized in event of inner vessel rupture.

Findings/Lessons Learned

- Solenoid valves designed to close in the event of vacuum pump failure or power loss were not functioning properly
  - Resulted in back-streaming of oil into vacuum annulus
- Periodic tank warm-up to be added to preventive maintenance schedule
  - GN2 purge and sampling for moisture and hydrocarbons
  - Helium leak checks

Path Forward

- Replace check valves on remaining 4 tanks with lift plates
  - Meeting relief requirements requires additional devices be installed
  - Multiple flanges on top of tanks available
  - Excessive corrosion on flanges requires stud extraction & resurfacing

Recommendations

- What is the status of the vacuum annulus on your tanks?
  - What level of monitoring do you have?
    - Would it alert you of a leak?
  - Periodic helium leak checks
- What is the condition of the positive pressure relief devices on the vacuum side of your tanks?
  - Are they periodically checked? (probably exempt since they're on a vacuum system…)

Questions